
	<b>EMBASSY OF THE UNITED STATES</b> Bogota, Colombia.  INTERNATIONAL NARCOTICS AND LAW ENFORCEMENT – I.N.L.	<b>PROJECT:</b> Generator – for SIMA  <b>LOCATION:</b> HANGAR I – Guyamaral, Colombia	<b>Number of Pages:</b> 10
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## 1. GENERAL TERMS OF REFERENCE

The CNP (Colombian National Police) Base in Guyamaral, Colombia requires a 500KVA Generator and Transfer System; In the performance of this contract the contractor shall provide all services to include but no limited to all equipment, labor, accommodation, food, supervision, management, VAT and other inherent to the proponent necessary to supply, transport, furnish, install, and configure a complete and functional Generator and Transfer System.

### 1.1. General Description of the Project

The Generator and Transfer System shall consist of new equipment to include but no limited to Generator Set, Sound Isolating Enclosure, Alternator, Battery Charger, Heater, Generator Main Breaker, Transfer System with Enclosure, Day Tank, Exhaust Piping and Muffler, Supporting Brackets anchoring and all the necessary components for a complete functional system.


Attachment 1 shows proposed locations for the location of the Generator but it is up to the Contractor to determine and insure that existing space will be appropriate for installation of the Generator and Transfer System.

The items are to be delivered, installed and commissioned at Guyamaral HANGAR I base. Installation and commissioning works are detailed in section 3 of this SOW.

This contract excludes the necessary infrastructure such as conduit, boxes and cable necessary to wire the devices this infrastructure is existing supplied by a separate CNP contractor, any additional requirements or missing infrastructure issues are to be notified to the contracting officer which will consequently expedite the repairs or additional works with the CNP, any delays caused by this process will be at no cost to the government.

### 1.2. Evaluation Criteria

The lowest priced proposal that is technically acceptable will be awarded the contract. The contractor shall submit all the information that demonstrates the proposed equipment is compliant and a schedule as per section 2.2.1 Execution Submittals.

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### 1.3. BID Chart

The Contractor shall provide pricing using the following bid Chart.


ITEM NO	UNIT	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
1	EA - each	Generator 500 KVA 208/120V 3Phase 60Hz Includes: Sound Proof , NEMA 4 Enclosure 8 Hr Full Load Capacity Day Tank CAT 3406C or Equivalent	1		\$ -
2	EA - each	ATS: Automatic Transfer System 4 Pole 100A	1		\$ -
3	LS- Lump Sum	Testing, Installation and Commissioning	1		\$ -
4	LS- Lump Sum	IVA	1		\$ -
<b>TOTAL</b>					<b>\$ -</b>

## 2. TECHNICAL TERMS OF REFERENCE


### 2.1. Relevant Codes and Standards:

The following publications form a part of this specification to the extent specified herein:

1. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI).
  - a. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
  - b. ANSI C50.13.89 - Rotating Electrical Machinery - Cylindrical Synchronous Generators"
  - c. ANSI/IEEE C57.13.1 - Field Testing of Relaying Current Transformers
  - d. ANSI Y32.2 - Graphic Symbols for Electrical and Electronics Diagrams.
2. AMERICAN PETROLEUM INSTITUTE (API).
  - a. API-CF - American petroleum institute classifications.
3. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM).
  - a. ASTM B117-90 - Standard Practices for Operating Salt Spray (Fog) Apparatus.
  - b. ASTM D523-89 - Standard Test Methods for Spectral Class.

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- c. ASTM D2247-92 - Standard Test for Testing Water Resistance of Coatings in 100 percent Relative Humidity.
- d. ASTM D2794-93 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- e. ASTM D3359-93 - Standard Test Methods for Measuring Adhesion by Tape Method.
- f. ASTM E-84-96 - Test Methods for Surface Burning Characteristic of building Material.
- 4. BRITISH STANDARDS INSTITUTE (BSI)
  - a. BS EN 55014 - 1993 Limits and Methods of Measurement of Radio Disturbance Characteristics of Electric Motor-Operator and Thermal Appliances for Household and Similar Purposes, Electric Tools and Similar Electric Apparatus (S).
- 5. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO).
  - a. ISO 3046 - Reciprocating internal combustion engines – Performance.
    - 1) 1995 - Part 1: Standard reference conditions, declarations of power, fuel and lubricating oil consumption's, and test method.
    - 2) 1989 - Part 3: Test.
    - 3) 1997 - Part 4: Speed governing.
    - 4) 1978 - Part 5: torsional vibrations.
    - 5) 1990 - Part 6: Overspeed protection.
    - 6) 1995 - Part 7: Codes for engine power.
  - b. ISO 8528 - Reciprocating internal combustion engine driven alternating current generating sets.
    - 1) 1993 - Part 1: Application, ratings and performance.
    - 2) 1993 - Part 2: Engines.
    - 3) 1993 - Part 3: Alternating current generators for generator sets.
    - 4) 1993 - Part 4: Control gear and switchgear.
    - 5) 1993 - Part 5: Generating sets.
    - 6) 1993 - Part 6: Test Methods.
    - 7) 1994 - Part 7: Technical declarations for specification and design.
    - 8) 1995 - Part 8: Requirements and tests for low- power generating sets.
    - 9) 1995 - Part 9: Measurement and evaluation of mechanical vibrations.
    - 10) 1998 - Part 10: Measurement of airborne noise by the enveloping surface method.
    - 11) 1997 - Part 12: Emergency power supply to safety devices.
  - c. ISO 9001:1994 - Quality systems - Model for quality assurance in design, development, production, installation and servicing.
- 6. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA).
  - a. MG1 - Standard for Motors and Generators.
  - b. MG2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
  - c. NEMA's STD Publication No. 250 - Enclosures for Electrical Equipment.
  - d. NEMA ICS 1 Industrial Controls and Systems.
- 7. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
  - a. NFPA 30 - Flammable and Combustible Liquids Code.
  - b. NFPA 70 - NATIONAL ELECTRIC CODE.
  - c. NFPA 110 - Standard for Emergency and Standby Power Systems.

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8. SOCIETY OF AUTOMOTIVE ENGINEERS (SAE).
  - a. SAE Handbook of Standards.
  - b. SAE J614B - Bayonet dip stick marking.
9. UNDERWRITERS LABORATORIES INC (UL).
  - a. UL142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
  - b. UL 1008 Automatic Transfer Switches
10. NORMA TECNICA COLOMBIA
  - a. NTC 4588
11. CODIGO ELECTRICO COLOMBIANO RETIE

Where two or more codes provide conflicting information the stringiest requirement will prevail.

## 2.2. Submittals

### 2.2.1. Proposal Submittals

The Contractor shall include in his proposal the following documents:

1. Catalogues and technical Specification Sheets for all Equipment highlighting the sections that demonstrate compliance with this scope of work.
2. Supply, Installation and start-up/commissioning Schedule.
3. The Contractor shall submit catalogs and technical spread sheets for all the devices and materials to be used during the project as well as a Schematic Diagram of the System to be installed. Lack and/or omission of such technical information shall render the proposal invalid and the proposal shall not be taken into consideration during the solicitation process.

### 2.2.2. Execution Submittals


Prior to beginning works, the Contractor shall submit a detail schedule of the work.

The Contractor shall provide Catalogues, and Technical Specifications as well as certifications for all material and equipment.

#### 2.2.2.1. Product Data

For System Components include descriptive and technical literature, catalog cuts, and installation instructions. Provide dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and UL listed data.

1. Installation manual. Include the following:
  - a. Genset noise levels at various distances from genset.
  - b. Allowable engine exhaust restriction if using an exhaust extension.
  - c. Allowable genset cooling air discharge restriction if cooling air is ducted away from genset.
  - d. Elevation and distance limits for location of external fuel supply.
  - e. Instructions for installation of all equipment, non-integral components, and accessories.
  - f. Instructions for aligning the genset before initial startup and after disassembly.

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#### 2.2.2.2. Shop Drawings

Shop drawings shall indicate fabrication details, dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection. Shop drawings shall not be smaller than 607 x 914 mm (24 x 36 inches) in size.

1. Locate and identify each interface point (lube drain, exhaust outlet, fuel inlet etc.), GROUNDING terminal, etc.
2. Indicate proper genset location such as allowable ground slope, clearance required for door opening, clearance required for engine exhaust, etc.
3. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
4. Design Calculations and Vibration Isolation Base Details.


#### 2.2.2.3. Administrative Data

1. Factory Test Reports: For units to be shipped for this Project, showing evidence of compliance with specified requirements.

#### 2.2.2.4. Maintenance Data

For each genset, provide maintenance manual tailored for the genset. Manuals shall have cover with clear identification tying manual to specific genset. All graphic symbols used on drawings shall conform to ANSI Y32.2.

1. Operators Manual: The operators manual shall accomplish and or contain the following information for minimally trained operators:
  - a. Permit the genset operator to identify and understand the function of each operator control.
  - b. Sufficient drawings and/or pictures to help the operator identify all the major genset components.
  - c. Proper instructions for the genset operator to determine if the genset voltage, frequency and kW rating is proper for the intended load.
  - d. Proper instructions for the genset operator to connect the genset ground terminal to an earth electrode (driven ground rod).
  - e. Proper instructions for the genset operator to safely connect the load cables to the genset output terminals. These instructions shall cover the load neutral connection and the phasing of the energized leads.
  - f. Step by step detailed instructions for the genset operator to thoroughly inspect the genset before attempting to start the genset for the first time.
  - g. Provide the genset operator a specific set of detailed instructions for STARTING, OPERATING and STOPPING the genset.
  - h. Provide the genset operator with a specific list of things to check EACH time the genset is started.
  - i. Provide the genset operator with a specific schedule of routine maintenance items such as lube oil changes, filter changes, etc.
  - j. Provide the genset operator of a complete list of acceptable lube oil, fuel oil, engine coolant, battery acid, etc.

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k. Provide the genset operator specific instructions for connecting the genset for remote operation from an ATS with or without a battery charger, including the location and identification of each interconnection point.

l. Provide the genset operator with an explanation of what type of records he needs to keep for each genset and the importance of accurate records.

m. Provide the genset operator with all applicable cautions, warnings and dangers for operation of the genset.

n. Provide the genset operator specific instructions for connecting electrical power to the engine coolant heater, auxiliary fuel pump, external fuel tank level signal, and emergency stop and wall mounted battery charger including the location and identification of each interconnection point.

o. Provide detailed instruction for reconnection of the genset power leads. Also provide detailed instructions for any required changes to the voltage regulator, governor, instrumentation and main circuit breaker to obtain the desired operating voltage and frequency.

p. Provide the value (fuel level, oil pressure, etc.) at which the warnings and shutdown devices will activate.


2. Parts Manual: The parts manual shall have sufficient drawings in a top down break down format to show each and every part in its relative position to the other parts. Each part, except standard hardware, shall have a unique part number and this part number shall be referenced to the part where it is shown on a drawing. In place of part numbers for standard hardware, the size of the hardware can be provided, such as "Machine Screw 4mm x 70 mm - 0.7mm pitch" or "Machine Screw 10-24 x 1 1/2". This manual shall also provide the source of supply for each part, including company name, address and phone number, and person to contact.

3. Service Manual: The service manual shall provide in narrative form the theory of operation for each of the major subsystems (generator and excitation system, governor, etc.) of the genset. This manual shall contain all applicable wiring and schematic diagrams. The manual shall also contain trouble shooting procedures and detailed procedures for removing and/or replacing each component.

#### **2.2.2.5. Testing and Acceptance Plan**

The Contractor shall perform and submit results of factory test as per NFPA 110 and as follows:

1. Start and Stop tests (local control).
2. Start and Stop tests (remote control).
3. Operation at rated load for two hours minimum.
4. Immediately after test above and before removing load, operate at 110 percent of rated load for one hour.
5. Application and dropping of rated load in one step (minimum of 5 times).
6. Check for proper operation of all indicators and controls.
7. Simulate each abnormal condition associated with each protective device to verify proper operation of shutdown protective system wiring.
8. Record voltage and frequency transients on a time based plot for step loads of 0 percent - 50 percent, 50 percent - 0 percent, 50 percent - 100 percent, 100 percent - 0 percent, and 0 percent - 100 percent of rated load.

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9. Measure total harmonic distortion of phase to neutral voltages at no load and 100 percent rated load.

10. ATS test of complete sequence of operation.

A government representative shall be present at the factory testing and the system shall be tested to demonstrate compliance with technical requirements.

The Contractor shall provide a testing and acceptance plan for final delivery, training and commissioning of the system.

#### **2.2.2.1. Demonstration**

The contractor shall demonstrate and train end users maintenance personnel before final acceptance in the operation and maintenance of the Generator and Transfer System. Training shall be at least 4 hours long for at least 4 people.

#### **2.2.2.2. Final Report**

For the final delivery of the project and after the work has been completed and approved by the contracting office and the end user, the following documentation shall be delivered in two (2) exact copies:

Final report of the designs in a 3 punch binder (original and copy) including:

Description of work executed, location, etc.

Drawings in letter size paper in AutoCAD® format

Calculations and tests.

Catalogues, Technical Data Sheets and Schematic Diagrams.

Operation and Maintenance Manuals.

List of spare Parts and Consumables.

Warranties.

Payment of invoice indicating the number of the order and discriminated against VAT.

Closing documentation to process payment signed by the legal representative work receipt.


### **2.3. Technical Specifications**

The following are the main characteristics of the work to be performed as described:

#### **2.3.1. Work general Description:**

The following are the main characteristics of the work to be executed at the HANGAR I Facilities located in Guyamaral, Cundinamarca. The work includes, but is not limited to supply and install of a 500KVA Stand by generator with a Transfer system. It is responsibility of the Contractor to verify the accuracy of the drawings and other document supplied by the US Embassy.

The required work for the system shall include the costs for repairing the affected areas during the project execution. The awarded Contractor shall comply with civil and electrical Colombian Constructions standards even if the affected areas do not.

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All works shall be performed following the specifications as per 2.1 relevant codes and standards.

Operating Ambient Temperatures for all Equipment shall be:

Temp: -13°C to 50°C

Humidity: 0% to 95% Relative Humidity

Altitude: Sea Level to 3.7km above installed location.

All Equipment to be supplied shall operate under high salt-dust content in the air due to sea-spray evaporation.

## 2.3.2. Detailed Information

### 2.3.2.1. Generator Set

The engine/generator shall be Stand by rated

Class 2 60Hz 208/120V 3 Phase 4 Wire

1800 RPM

Diesel Fuel

Skid Base Mounted

Spring Isolators

Circuit Breaker Mounted on the Genset Assembly and rated for the full load amps.

Shunt Excitation System

Corrosion Resistant Fabrication on all parts and subparts.

Deviation factor from Line to neutral and Line to Line shall not exceed 5%.

Telephone Influence Factor TIF shall not exceed 50.

Voltage Regulation Shall be less than or equal to 0.5% of rated voltage.

Voltage Stability: At any constant load from no load to 110% of rated load the voltage shall remain with a bandwidth of one percent of rated voltage.

Generator and Excitation systems shall conform to G4 of ISO 8528.

The genset shall start within 10 seconds of receiving a start signal

The genset shall stop within 30 seconds of receiving a stop signal.

After power has returned the Generator and after load has been transferred to normal power the generator shall run for 5 minutes before stopping.

The generator shall be capable of running at 115% Overspeed for 5 minutes without damage.

The generator shall have a sound attenuating accessories to reduce sound pressure at 7 meters by -70dBA.


The genset shall have a life expectancy of 10,000 hours

The design of the Generator and Sound attenuating enclosure shall permit easy servicing and maintenance procedures.

The Exhaust system shall include and industrial type Muffler.

The Exhaust system shall include a rain cap to discharge smoke.

The generator shall include a underbelly mounted day tank capable of providing 9 hours of power at 100% Load.

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Batteries shall be included inside the generator set and shall have flexible cabling oil and acid resistant.

The generator shall not be damaged in case of polarity reversal of the battery cables. The generator shall include and integrally mounted battery charger and preheating system.

The genset shall include a control panel readily accessible mounted on a vibration isolated enclosure with the following meters and gauges with readings available for all phases:

AC Ammeter  
AC Voltmeter  
Frequency Meter  
Kilowatt Meter  
Oil Pressure Gauge  
Coolant Temperature  
Running time Meter  
DC Volt Meter (Battery)

The genset shall include the following controls:

Voltage Adjustment rheostat (5%)  
Frequency Adjustment (5%)  
RUN-STOP-AUTO  
Fault Light and Code Indicating Fault Code


The genset shall include the following Monitor Information Lights:

Run	(Green)
Not in Automatic	(Red Flashing)
Warning (For any Fault Condition)	(Yellow Flashing)
Failure (For any shutdown Condition)	(Red)

Fault Conditions are Low Oil Pressure, High Coolant Temperature, Low Battery Voltage and Overspeed at critical conditions of this measurements determined by the vendor the Fault conditions must become shutdown conditions and stop the generator automatically.

### 2.3.2.2. Automatic Transfer Switch

A 4 pole automatic transfer switch and enclosure shall be provided with a continuous current rating equal to the rating of the generator. The switch shall have a break before make configuration so that all 3 poles and neutral open and close at the same time and shall be mechanically interlocked to prevent simultaneous closing of normal and backup contacts. The mains switch contacts shall be long life, high pressure, and silver alloy contacts with separate arcing areas. Neutral Bus of the ATS shall be electrically isolated from enclosure and be rated at 200%. The Ground Bus of the ATS shall be bonded to the enclosure and be rated at 100%. All terminals shall include tinned copper lugs to install wiring up to one size

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larger than required for the current rating. The ATS shall be capable of being operated manually via a handle readily accessible in the outside of the enclosure to accomplish both transfer and retransfer of load.

- 2.3.2.2.1. Sequence of Operation:
- When the voltage on any phase of the normal source (commercial power) is reduced to 80 percent of rated voltage (adjustable from 75 percent to 98 percent of pickup voltage) for more than 10 seconds (adjustable 0 to 15), the starting contacts shall close.
  - When the genset has started and obtained 90 percent of rated voltage (adjustable 85- 100 percent) on all phases and rated frequency, the load shall be transferred to the genset after 30 seconds (adjustable 2 to 120).
  - When the normal source has been restored and the voltage of all phases has been within 90 percent of rated voltage (adjustable 85-100 percent) for 15 minutes (adjustable 0 - 30), the load shall transfer to normal power.
  - The genset shall continue to run for 10 (adjustable 1 to 10) minutes before it automatically stops. The system shall now be ready for another failure cycle.
- 2.3.2.2.2. Controls
- There shall be a three position, key operated switch labeled "TEST", "NORMAL" and "RETRANSFER" located on the enclosure door.
- Test position (ATS): In the "TEST" position the genset shall automatically start come up to rated speed and rated voltage, but the ATS shall not transfer the load to the genset.
  - Normal position (ATS): In the "NORMAL" position the ATS functions in the completely automatic mode.
  - Retransfer position (ATS): In the "RETRANSFER" position the ATS immediately transfers the load to commercial source bypassing any preset transfer delays.
- 2.3.2.2.3. Indicators
- There shall be four indicator lights, properly labeled as to function mounted on the enclosure door. Two of the indicator lights are to be labeled to show the position of the main switch. The other two indicating lights are to be labeled to show the status of the two sources.

### 3. EXECUTION

#### 3.1 EXAMINATION

After becoming familiar with all details of the work, perform a Site Visit to verify details of the work. Submit a site visit letter stating the date the site was visited and listing discrepancies found and advise the Contracting Officer in writing of any discrepancies before performing any work.

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### 3.2 GENERAL INSTALLATION

Submit a complete copy of the manufacturer's installation procedures. A detailed description of the manufacturer's recommended break-in procedure.

Provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Configure installation of pipe, duct, conduit, and ancillary equipment to facilitate easy removal and replacement of major components and parts of the engine-generator set.

### 3.3 PIPING INSTALLATION

#### General

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturer's standard connection is threaded. Except as otherwise specified, flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to all equipment shall be made with flexible connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors, and openings to permit thermal expansion and contraction without damage to joints or hangers, and with a 1/2 inch drain valve at each low point.

#### Supports

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but no larger than 4 inches, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be provided at pipe bends or change of direction.


#### Ceiling and Roof

Exhaust piping shall be supported with appropriately sized type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized type 1 clevis and threaded rods.

#### Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized type 33 brackets with the appropriate ceiling and roof pipe supports.

#### Flanged Joints

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Flanges shall be 125 pound type, drilled, and of the proper size and configuration to match equipment and diesel-engine connections. Gaskets shall be factory cut in one piece 1/16 inch thick.

#### Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of all debris.

#### Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be 1/2 inch, and where pipes pass through combustible materials, 1 inch larger than the outside diameter of the passing pipe or pipe covering.


### 3.4 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, flexible fittings shall be provided for all conduit, cable trays, and raceways attached to engine-generator sets; metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor; and terminations of conductors on the engine generator set shall be crimp-type terminals or lugs. Submit manufacturer's standard certification that prototype tests were performed for the generator model proposed.

### 3.5 ONSITE INSPECTION AND TESTS

#### Submittal Requirements

- a. A letter giving notice of the proposed dates of all onsite inspections and tests at least 14 days prior to beginning tests.
- b. A detailed description of the Contractor's proposed procedures for onsite tests including the test including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least 7 days prior to beginning tests.
- c. Two copies of the onsite test data described below in 8-1/2 by 11 inch 3-ring binders with a separate section for each test. Sections shall be separated by dividers with tabs. Data plots shall be full size 8-1/2 by 11 inches minimum), showing all grid lines, with full resolution.
  - (1) A description of the procedures for onsite tests.
  - (2) A list of equipment used, with calibration certifications.
  - (3) A copy of measurements taken, with required plots and graphs.

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- (4) The date of testing.
- (5) The parameters verified.
- (6) The condition specified for the parameter.
- (7) The test results, signed and dated.
- (8) A description of all adjustments made.

#### Test Conditions

#### Data

Measurements shall be made and recorded of parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments or replacements shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be taken during engine-generator set operation and recorded in 15 minute intervals and shall include: readings of engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Electrical measurements shall be performed in accordance with IEEE 120. Definitions and terms are in accordance with IEEE Stds Dictionary. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE 1.


#### Contractor Supplied Items

Provide all equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

#### Instruments

Readings of panel gauges, meters, displays, and instruments, provided under this specification shall be verified during test runs by test instruments of precision and accuracy greater than the tested items. Test instrument accuracy shall be at least as follows: current, 1.5 percent; voltage, 1.5 percent; real power, 1.5 percent; reactive power, 1.5 percent; power factor, 3 percent; frequency, 0.5 percent. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

#### Sequence

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The sequence of testing shall be as specified in the approved testing plan unless variance in authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however the following general order of testing shall be followed: Construction Tests; Inspections; Safety run Tests; and Performance Tests and Final Inspection.

#### Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.


#### Piping Test

- a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.
- b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine generator set shall be pressure tested with air pressure at 150 percent of the maximum anticipated working pressure, but in no case less than 150 psig, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

#### Electrical Equipment Tests

- a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

- (1)  $R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 304,800 / (\text{length of cable in meters})$ .
- (2)  $R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$
- (3) Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

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c. Ground-Resistance Tests. The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.


- (1) Single rod electrode - 5 ohms.
- (2) Multiple rod electrodes - 5 ohms.
- (3) Ground mat - 5 ohms.

d. Circuit breakers and switchgear shall be examined and tested in accordance with manufacturer's published instructions for functional testing.

#### Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented and submitted as a letter certifying that all facilities are complete and functional, that each system is fully functional, and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use. Present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.


1. Drive belts. (I)
2. Governor type and features. (I)
3. Engine timing mark. (I)
4. Starting motor. (I)
5. Starting aids. (I)
6. Coolant type and concentration. (D)
7. Radiator drains. (I)
8. Block coolant drains. (I)
9. Coolant fill level. (I)
10. Coolant line connections. (I)
11. Coolant hoses. (I)
12. Combustion air filter. (I)
13. Intake air silencer. (I)
14. Lube oil type. (D)
15. Lube oil drain. (I)
16. Lube-oil filter. (I)
17. Lube-oil-fill level. (I)

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18. Lube-oil line connections. (I)
19. Lube-oil lines. (I)
20. Fuel type. (D)
21. Fuel-level. (I)
22. Fuel-line connections. (I)
23. Fuel lines. (I)
24. Fuel filter. (I)
25. Access for maintenance. (I)
26. Voltage regulator. (I)
27. Battery-charger connections. (I)
28. Wiring & terminations. (I)
29. Instrumentation. (I)
30. Hazards to personnel. (I)
31. Base. (I)
32. Nameplates. (I)
33. Paint. (I)
34. Exhaust system. (I)
35. Access provided to controls. (I)
36. Enclosure. (I)
37. Engine & generator mounting bolts (proper application). (I)

#### Safety Run Tests

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- c. Activate the manual emergency stop switch and verify that the engine stops.
- d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary, provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If temperature reading exceeds the value for an alarm condition, activate the manual emergency stop switch.
- f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

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g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily seal their normal location on the engine and temporarily install temperature gauges in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 30 minutes at 100 percent of service load.

l. Verify proper operation of the governor and voltage regulator.

m. Verify proper operation and setpoints of gauges and instruments.

n. Verify proper operation of ancillary equipment.


o. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.

p. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of rated load.

q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine. Record the results.

s. Attach a manifold to the engine oil system (at the oil sensor pressure port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold and its normal location on the engine temporarily sealed. The manifold shutoff valve shall be open and bleed valve closed.

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t. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of service load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of service load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge horizontal piping; or at a radius of 35 feet from the engine at 45 degrees apart in all directions for vertical piping. The measurements should comply with the paragraph SOUND LIMITATIONS. The sound limiting enclosure provided, the enclosure, the muffler, and intake silencer shall be modified or replaced as required to meet the sound requirements contained within this specification.

w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.


#### Performance Tests

Submit calculations of the engine and generator output power capability, including efficiency and parasitic load data.

#### Continuous Engine Load Run Test

The engine-generator set and ancillary systems shall be tested at service load to: demonstrate reliability and durability (see paragraph RELIABILITY AND DURABILITY for submittal requirements); verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, starting at noon. Data taken at 15 minutes intervals shall include the following:

- a. Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.
- b. Pressure: Lube-oil.
- c. Temperature: Coolant, Lube-oil, Ambient.

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- (1) Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.
- (2) Start the engine; make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- (3) Operate the engine generator-set for at least 2 hours at 75 percent of service load.
- (4) Increase load to 100 percent of service load and operate the engine generator-set for at least 2 hours.
- (5) Remove load from the engine-generator set.

#### Load Acceptance Test


Engine manufacturer's recommended prestarting checks and inspections shall be performed and recorded. The engine shall be started, and engine manufacturer's after-starting checks and inspections made and recorded during a reasonable warm-up period. For the following steps, the output line-line and line-neutral voltages and frequency shall be recorded after performing each step instruction (after stabilization of voltage and frequency). Stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings.

- a. Apply load in steps no larger than the Maximum Step Load Increase to load the engine-generator set to 100 of Service Load.
- b. Verify that the engine-generator set responds to the load addition and that the output voltage returns to and stabilizes within the rated bandwidths.

#### Automatic Operation Tests for Stand-Alone Operation

The automatic loading system shall be tested to demonstrate automatic starting, and loading and unloading of engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

- a. Ambient temperature (at 15 minute intervals).
- b. Generator output current (before and after load changes).
- c. Generator output voltage (before and after load changes).
- d. Generator output frequency (before and after load changes.)

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- (1) Initiate loss of the primary power source and verify automatic sequence of operation.
- (2) Restore the primary power source and verify sequence of operation.
- (3) Verify resetting of controls to normal.

### 3.6 ONSITE TRAINING


Conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations such as oil change, oil filter change, and air filter change.

### 3.7 FINAL INSPECTION AND TESTING

- a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. Increase the load in steps no greater than the maximum step load increase to 100 percent of service load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.
- c. Remove load and shut down the engine-generator set after the recommended cool down period. Perform the pre-test inspections and take necessary corrective actions.
- d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 4 hours at service load, then re-examining the oil and filter.
- e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.
- f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.
- g. Replace air, oil, and fuel filters with new filters.

### 3.8 MANUFACTURER'S FIELD SERVICE

The engine generator-set manufacturer shall furnish a qualified representative to supervise the installation of the engine generator-set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment.

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### 3.9 INSTRUCTIONS

A set of instructions shall be typed and framed under weatherproof laminated plastic, and posted side-by-side where directed before acceptance. First set of instructions shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set of instructions shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; start procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).

### 3.10 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

Submit drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them with the as-built drawings.